Practitioner's Docket No. 413-010522-US(PAR)

CHAPTER II

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: *"All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P., § 601, 7th ed.*

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US) (ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FI00/00274	30 March 2000	31 March 1999

TITLE OF INVENTION

Inverted Microstrip Transmission Line Integrated In A Multilayer Structure

APPLICANT(S)

Olli SALMELA

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10*
*(When using Express Mail, the Express Mail label number is **mandatory**; Express Mail certification is optional.)*

I hereby certify that, on the date shown below, this correspondence is being:

MAILING

XX deposited with the United States Postal Service in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

37 C.F.R. § 1.8(a)

☐ with sufficient postage as first class mail.

37 C.F.R. § 1.10 *

XX as "Express Mail Post Office to Addressee"
Mailing Label No. EL627426941US **(mandatory)**

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703) _____-_____.

Deborah J Clark
Signature

Date: 24 September 2001

Deborah J. Clark
(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. § 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing—See 37 C.F.R. § 1.8.*

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 U.S.C. § 371 otherwise the submission will be considered as being made under 35 U.S.C. § 111. 37 C.F.R. § 1.494(f).

I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. § 371:

a. ☒ This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).

b. ☒ The U.S. National Fee (35 U.S.C. § 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
☐*	TOTAL CLAIMS 7	7 −20=	0	× $18.00=	$ 0
	INDEPENDENT CLAIMS 1	1 −3=	0	× $80.00=	0
	MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	
BASIC FEE**	☐ U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: ☐ and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 C.F.R. § 1.492(a)(4)) ..... $100.00 ☐ and the above requirements are not met (37 C.F.R. § 1.492(a)(1)) ..... $690.00 ☒ U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: ☐ has been paid (37 C.F.R. § 1.492(a)(2)) ..... $710.00 ☒ has not been paid (37 C.F.R. § 1.492(a)(3)) ..... $1000.00 ☐ where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 C.F.R. § 1.492(a)(5)) $860.00				1,000.00
	Total of above Calculations				= 1,000.00
SMALL ENTITY	Reduction by 1/2 for filing by small entity, if applicable. Assertion must be made. (note 37 C.F.R. § 1.27)				−
	Subtotal				1,000.00
	Total National Fee				$ 1,000.00
	Fee for recording the enclosed assignment document $40.00 (37 C.F.R. § 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				40.00
TOTAL	Total Fees enclosed				$ 1,040.00

*See attached Preliminary Amendment Reducing the Number of Claims.

☒ Attached is a ☒ check ☐ money order in the amount of $ 1,040.00

☐ Authorization is hereby made to charge the amount of $ _____

☒ to Deposit Account No. 16-1350

☐ to Credit card as shown on the attached credit card information authorization form PTO-2038.

WARNING: *Credit card information should* ***not*** *be included on this form as it may become public.*

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

"WARNING: *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

☐ **Assertion of Small Entity Status**

☐ **Applicant hereby asserts status as a small entity under 37 C.F.R. § 1.27.**

NOTE: 37 C.F.R. § 1.27(c) deals with the assertion of small entity status, whether by a written specific declaration thereof or by payment as a small entity of the basic filing fee or the fee for the entry into the national phase as states:

"(c) Assertion of small entity status. Any party (person, small business concern or nonprofit organization) should make a determination, pursuant to paragraph (f) of this section, of entitlement to be accorded small entity status based on the definitions set forth in paragraph (a) of this section, and must, in order to establish small entity status for the purpose of paying small entity fees, actually make an assertion of entitlement to small entity status, in the manner set forth in paragraphs (c)(1) or (c)(3) of this section, in the application or patent in which such small entity fees are to be paid.

(1) Assertion by writing. Small entity status may be established by a written assertion of entitlement to small entity status. A written assertion must:

(i) Be clearly identifiable;

(ii) Be signed (see paragraph (c)(2) of this section); and

(iii) Convey the concept of entitlement to small entity status, such as by stating that applicant is a small entity, or that small entity status is entitled to be asserted for the application or patent. While no specific words or wording are required to assert small entity status, the intent to assert small entity status must be clearly indicated in order to comply with the assertion requirement.

(2) Parties who can sign and file the written assertion. The written assertion can be signed by:

(i) One of the parties identified in §§ 1.33(b) (e.g., an attorney or agent registered with the Office), §§ 3.73(b) of this chapter notwithstanding, who can also file the written assertion;

(ii) At least one of the individuals identified as an inventor (even though a §§ 1.63 executed oath or declaration has not been submitted), notwithstanding §§ 1.33(b)(4), who can also file the written assertion pursuant to the exception under §§ 1.33(b) of this part; or

(iii) An assignee of an undivided part interest, notwithstanding §§ 1.33(b)(3) and 3.73(b) of this chapter, but the partial assignee cannot file the assertion without resort to a party identified under §§ 1.33(b) of this part.

(3) Assertion by payment of the small entity basic filing or basic national fee. The payment, by any party, of the exact amount of one of the small entity basic filing fees set forth in §§ 1.16(a), (f), (g), (h), or (k), or one of the small entity basic national fees set forth in §§ 1.492(a)(1), (a)(2), (a)(3), (a)(4), or (a)(5), will be treated as a written assertion of entitlement to small entity status even if the type of basic filing or basic national fee is inadvertently selected in error.

(i) If the Office accords small entity status based on payment of a small entity basic filing or basic national fee under paragraph (c)(3) of this section that is not applicable to that application, any balance of the small entity fee that is applicable to that application will be due along with the appropriate surcharge set forth in §§ 1.16(e), or §§ 1.16(l).

(ii) The payment of any small entity fee other than those set forth in paragraph (c)(3) of this section (whether in the exact fee amount or not) will not be treated as a written assertion of entitlement to small entity status and will not be sufficient to establish small entity status in an application or a patent."

3. ☒ A copy of the International application as filed (35 U.S.C. § 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. ☐ is transmitted herewith.

b. ☐ is not required, as the application was filed with the United States Receiving Office.

c. ☒ has been transmitted

i. ☒ by the International Bureau.

Date of mailing of the application (from form PCT/1B/308): 10/19/00

ii. ☐ by applicant on _____. *(Date)*

4. ☒ A translation of the International application into the English language (35 U.S.C. § 371(c)(2)):

a. ☒ is transmitted herewith.

b. ☐ is not required as the application was filed in English.

c. ☐ was previously transmitted by applicant on _____. *(Date)*

d. ☐ will follow.

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

a. ☐ are transmitted herewith.

b. ☐ have been transmitted

i. ☐ by the International Bureau.

Date of mailing of the amendment (from form PCT/1B/308):

_____.

ii. ☐ by applicant on _____. *(Date)*

c. ☐ have not been transmitted as

i. ☒ applicant chose not to make amendments under PCT Article 19. Date of mailing of Search Report (from form PCT/ISA/210.):

8/28/00.

ii. ☐ the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. ☐ A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. § 371(c)(3)):

a. ☐ is transmitted herewith.

b. ☐ is not required as the amendments were made in the English language.

c. ☐ has not been transmitted for reasons indicated at point 5(c) above.

7. ☒ A copy of the international examination report (PCT/IPEA/409)

☒ is transmitted herewith.

☐ is not required as the application was filed with the United States Receiving Office.

8. ☐ Annex(es) to the international preliminary examination report

a. ☐ is/are transmitted herewith.

b. ☐ is/are not required as the application was filed with the United States Receiving Office.

9. ☐ A translation of the annexes to the international preliminary examination report

a. ☐ is transmitted herewith.

b. ☐ is not required as the annexes are in the English language.

10. ☒ An oath or declaration of the inventor (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115 09/937506

a. ☐ was previously submitted by applicant on _____. *(Date)*

b. ☒ is submitted herewith, and such oath or declaration

i. ☒ is attached to the application.

ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. § 1.70.

c. ☐ will follow.

II. Other document(s) or information included:

11. ☒ An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

a. ☒ is transmitted herewith.

b. ☐ has been transmitted by the International Bureau.

Date of mailing (from form PCT/IB/308): _____.

c. ☐ is not required, as the application was searched by the United States International Searching Authority.

d. ☐ will be transmitted promptly upon request.

e. ☐ has been submitted by applicant on _____. *(Date)*

12. ☒ An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98:

a. ☒ is transmitted herewith.

Also transmitted herewith is/are:

☒ Form PTO-1449 (PTO/SB/08A and 08B).

☒ Copies of citations listed.

b. ☐ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. § 371(c).

c. ☐ was previously submitted by applicant on _____. *(Date)*

13. ☒ An assignment document is transmitted herewith for recording.

A separate ☒ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

_____

_____

_____

14. ☒ Additional documents:
    a. ☒ Copy of request (PCT/RO/101)
    b. ☒ International Publication No. WO 00/62368
        i. ☐ Specification, claims and drawing
        ii. ☒ Front page only
    c. ☒ Preliminary amendment (37 C.F.R. § 1.121)
    d. ☒ Other
    PCT/IB/308; PCT/IPEA/409; PCT/IB/304; PCT/IB/306; PCT/IPEA/401

15. ☒ The above checked items are being transmitted
    a. ☒ before 30 months from any claimed priority date.
    b. ☐ after 30 months.

16. ☐ Certain requirements under 35 U.S.C. § 371 were previously submitted by the applicant on _____, namely:

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

☒ Please charge, in the manner authorized above, the following additional fees that may be required by this paper and during the entire pendency of this application:

☒ 37 C.F.R. § 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

☒ 37 C.F.R. § 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

☒ 37 C.F.R. § 1.17 (application processing fees)

☒ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a).

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

☒ 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 24,622

Clarence A. Green

(type or print name of practitioner)

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PERMAN & GREEN, LLP

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Express Mail No.: EL627426941US
In re Application of: Olli SALMELA
INTERNATIONAL APPLICATION NO.: PCT/FI00/00274
INTERNATIONAL FILING DATE: 30 March 2000
TITLE: INVERTED MICROSTRIP TRANSMISSION LINE INTEGRATED IN A MULTILAYER STRUCTURE
ATTORNEY DOCKET NO.: 413-010522-US(PAR)

Box PCT
The Commissioner of Patents and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the above-identified, patent application as follows:

IN THE SPECIFICATION:

After the Title and before the first paragraph, please insert the following paragraph:

This application claims the benefit of the earlier filed International Application No. PCT/FI00/00274, International Filing Date, 30 March 2000, which designated the United States of America, and which international application was published under PCT Article 21(2) in English as WO Publication No. WO 00/62368.

IN THE CLAIMS

Please amend the Claims as rewritten below:

Claims

What is claimed is:

1. A transmission cable constructed by multilayer technique, located in a cavity comprising a first surface and a second surface which is essentially parallel with the first surface,

said transmission cable consisting of

a signal cable, which is essentially parallel to the first cavity surface,

and of a ground cable, which is placed on said second surface, essentially in parallel with the signal cable,

and said transmission cable also comprises a support element which has a surface that is essentially parallel with said first and second surfaces and is located between said first and second surfaces, so that said signal cable is realised by means of an electroconductive material layer formed on the surface of the support element.

2. A transmission cable according to claim 1, wherein the support element is rectangular in shape.

3. A transmission cable according to claim 1, wherein the support element is a square.

4. A transmission cable according to claim 1, wherein the shape of the support element is a T-beam.

5. A transmission cable according to claim 1, wherein the shape of the support element is a surface formed by two curved surfaces.

6. A transmission cable according to claim 1, wherein the signal cable is an inverted microstrip cable.

7. A transmission cable according to claim 1, wherein the signal cable is a coplanar cable.

REMARKS

In accordance with 37 C.F.R. §1.121 (as amended on 11/7/2000) the rewritten claim(s) above are shown on separate page(s) marked up to show all the changes relative to the previous version of that section.

Respectfully submitted,

24Sep01
Date

Clarence A. Green / Reg. No.: 24,622
PERMAN & GREEN, LLP
425 Post Road, Fairfield, CT 06430
(203) 259-1800
Customer No.: 2512

Application entitled: INVERTED MICROSTRIP TRANSMISSION LINE INTEGRATED IN A MULTILAYER STRUCTURE

MARKED UP CLAIMS:

Claims

What is claimed is:

1. A transmission cable constructed by multilayer technique, located in a cavity comprising a first surface and a second surface which is essentially parallel with the first surface,

said transmission cable consisting of

_____ a signal cable ~~(20, 30, 40, 50, 60)~~, which is essentially parallel to the first cavity surface,

_____ and of a ground cable ~~(21, 31, 41, 51, 61)~~, which is placed on said second surface, essentially in parallel with the signal cable,

and said transmission ~~characterised in that said~~ cable also comprises a support element ~~(25, 35, 45, 55, 65)~~ which has a surface that is essentially parallel with said first and second surfaces and is located between said first and second surfaces, so that ~~the~~ said signal cable is realised by means of an electroconductive material layer formed on the surface of the support element.

2. A transmission cable according to claim 1, ~~characterised~~ wherein the ~~in that said~~ support element

~~(25, 35, 45)~~ is rectangular in shape.

3. A transmission cable according to claim 1, ~~characterised~~wherein the~~ in that the~~ support element is a square~~ (25)~~.

4. A transmission cable according to claim 1, ~~characterised~~wherein the ~~in that~~ shape of the support element is a T-beam~~ (55)~~.

5. A transmission cable according to claim 1, ~~characterised~~wherein the ~~in that the~~ shape of the support element is a surface~~ (65)~~ formed by two curved surfaces.

6. A transmission cable according to claim 1, ~~characterised~~wherein the ~~in that the~~ signal cable is an inverted microstrip cable.

7 A transmission cable according to claim 1, ~~characterised~~wherein the ~~in that the~~ signal cable is a coplanar cable.

Inverted microstrip transmission line integrated in a multilayer structure

The invention relates to a transmission cable constructed by multilayer technique, said cable being located in a cavity with a first surface and a second surface essentially parallel to the first, said transmission cable consisting of a signal cable that is essentially parallel with the first surface of the cavity, and of a ground cable that is placed on said second surface, essentially in parallel with the signal cable.

Various different cable structures are utilised in the construction of electronic appliances. The higher the employed frequencies, the higher the requirements set for the cable structures to be used, in order to prevent attenuation caused by said cable structures. At present, in the structures of electronic appliances, there is generally applied the so-called multilayer technique, which is based either on the HTCC technique (High Temperature Cofired Ceramics) or on the LTCC technique (Low Temperature Cofired Ceramics). With both manufacturing methods, the produced structures consist of several green tapes, with a thickness of about 100 µm, which are positioned one on top of the other. Prior to thermal treatment, the material still is soft, so that in the green tapes, there can be made cavities of desired shapes. Likewise, at desired spots, there can be silk-screened various electrically passive elements. The elastic layers are laminated together by means of pressure. In order to prevent the lamination pressure from collapsing the structure that contains various cavities, the pressurising must be carried out according to a so-called unaxial method. This means that the pressure is directed to the object only in the direction of the axis z of said object. Finally the created structure is burnt, in the case of LTCC at 850 degrees and in the case of HTCC at 1,600 degrees. In the elements to be produced, at the cavities there are made perforations through which the excess pressure created in the burning process can be let out.

In figures 1a and 1b, there is illustrated a possible alternative for realising an inverted microstrip cable based on the HTCC or LTCC multilayer technique according to the description above. In a preferred embodiment, the structure according to figure 1a is achieved by joining together, during the production process but prior to the burning step of the structure, the exemplary elements 12 and 13 illustrated in the drawing . Both of said elements are made layer by layer of some suitable dielectric material in a fashion described above. In the element 13, there is machined a rectangular groove, on the bottom of which there is silk-screened a signal cable 10. The thickness 18 of the element 13, when measured at

the bottom of the groove, is sufficient to prevent disturbing ground potential levels from coming close to the described inverted microstrip cable. In the example illustrated in the drawing , the angle between the side walls of the groove made in the element 13 and the groove bottom 16, 17 is 90 degrees, but in principle the angles can have some other size, too. On the surface of the element 12, there is silk-screened a ground cable 11, the width whereof corresponds to the width of the groove made in the element 13. The elements 12 and 13 are machined separately, and when they are connected, there is obtained a structure according to figure 1a, where there is created a gas-filled cable cavity 14.

In figure 1b, there is illustrated a cross-section made in the direction A - A' of figure 1a. The attenuation and impedance of a transmission cable according to the invention are determined by the permittivity (ε_r) of the employed elements 12 and 13, as well as the geometric shape of the groove. From the drawing it is seen that the electromagnetic field emitted from the signal cable 10, said field in the drawing being illustrated by the power lines 15, proceeds a long way inside the element 13. With RF frequencies, the permittivity of the element 13 is clearly higher than the permittivity of the gas mixture filling the cable cavity 14. This results in that the cable attenuation is strongly increased with RF frequencies. The final multilayer structure of the apparatus also includes other material layers than those illustrated in figures 1a and 1b, in which layers there may be provided passive components, cavities for active components and other cable structures, too.

However, the use of electric circuits manufactured by the above described techniques becomes problematic, if very high frequencies must be used (RF applications). Signal attenuation in a cable structure realised with LTCC technique at the frequency of 20 GHz rises up to 0,2 dB/cm, and in a cable structure realised with HTCC technique up to 0,6 dB/cm. In such RF applications where low attenuation is required, for example in filters and oscillation sources having a high quality factor (Q value), the above described techniques are no longer feasible.

Another problem with regular microstrip cables or inverted microstrip cables is the impedance level of the transmission cables realised by means of structures. An uncontrolled fluctuation of the impedance level results in undesired reflections of the signal back in the direction where the signal came from, or in radiation in the cable surroundings. Impedance is affected by the geometric shape of the cable structure, as well as by the relative permittivity (ε_r) of the surrounding material layers. In prior art structures, the above described two factors are the only free choices for adjusting the impedance.

With prior art LTCC and HTCC structures, another drawback is presented in the dispersion of the phase velocity with high frequencies. In a dispersed signal, the signal components contained therein at different frequencies have passed through the transmission cable at different velocities. This phenomenon distorts the received signal, and an excessive increase of the dispersion results in that the received signal becomes inapplicable.

From the US patent publication 3,904,997 there is known an arrangement where the signal cable of an inverted microstrip resting on a substrate is encased in a shell-like structure made of metal. By means of this arrangement, both the attenuation of the transmission cable and the stray radiation scattered from the cable are attempted to be reduced. The metallic cable cavity must always be manufactured in advance, and its fastening in a reliable way to the rest of the multilayer structure causes problems. The fact that the thermal expansion coefficient of the metallic cable cavity is different from the basic substrate may cause the structure to break at the junction surface. Moreover, the structure includes a lot of manually performed work steps, wherefore it also is expensive in manufacturing costs.

From the US patent publication 5,105,055 there is known an arrangement where in one flexible, cable-like structure there are integrated several cables. In said structure, the signal cable is attached to a dielectric substrate, and the ground cable is placed in a cavity-like structure made of another dielectric material. In principle, said cable is an entity made of several inverted microstrip cables. The materials of the cable structure are chosen among such materials that are elastic, and they can be processed with extrusion devices designed for processing plastics. Several variations of the cable structure are presented in the publication. According to said publication, the cable is meant to be used in connection with personal PC devices. Also in this case it is pointed out that owing to the target of usage, the materials chosen in the structure do not enable the use of RF frequencies.

The object of the invention is to reduce the described drawbacks connected to the prior art.

The transmission cable placed in a cavity according to the invention is characterised in that it comprises a support element with a surface essentially parallel to the first and second surfaces of the cavity, said support element being placed between said first and second surfaces, so that the signal cable is realised by

means of an electroconductive material layer formed on the surface of said support element.

A number of preferred embodiments of the invention are set forth in the independent claims.

The basic principle of the invention is as follows: by applying multilayer technique, there is manufactured a modified, inverted microstrip cable, where the signal cable is attached, by means of a specially designed support element, on one surface of the cable cavity. Thus the effect of the material layers that encase the cable to the electromagnetic field surrounding said cable is remarkably reduced.

An advantage of the invention is that at RF frequencies the attenuation of a transmission cable according to the invention is clearly lower than with existing inverted microstrip cables, because the electromagnetic field emitted from the signal cable is mainly located in the gas-filled cable cavity, the permittivity (ε_r) of said cable cavity with respect to the permittivity of the surrounding dielectric materials being low.

Another advantage of the invention is that the transmission cable can be fully integrated in a multilayer structure without any specific work steps carried out expressly for this purpose.

Yet another advantage of the invention is that thereby the impedance level of the transmission cable can be adjusted as desired in a simple fashion.

The invention is explained in more detail below. The description refers to the accompanying drawings, wherein

figure 1a shows in a perspective illustration a prior art inverted microstrip cable realised by multilayer technique,

figure 1b shows a cross-section of the transmission cable of figure 1a, seen along the line A - A',

figure 2 shows in cross-section a preferred embodiment according to the invention,

figure 3 shows in cross-section another preferred embodiment according to the invention,

figure 4 shows in cross-section a third preferred embodiment according to the invention,

figure 5 shows in cross-section a fourth preferred embodiment according to the invention, and

figure 6 shows in cross-section a fourth preferred embodiment according to the invention,

Figures 1a and 1b were already dealt with in connection with the description of the prior art.

Figures 2 - 6 represent a few preferred embodiments according to the invention. All embodiments illustrated in the drawings consist of elements manufactured by multilayer technique, which elements can in the manufacturing process be combined to form a uniform structure. In the preferred embodiment of the invention illustrated in figure 2, the signal cable 20 of an inverted microstrip cable is attached to a support element 25 according to the invention. The walls surrounding the transmission cable can be made in a process explained above, in connection with the description of the prior art, for instance of two or more elements 22 and 23, which both are compiled of several green tapes. The sectional plane 26 of the elements, perpendicular to the patterns, is chosen so that the number of work steps in the manufacturing process is minimised. The support element 25 can likewise be made in several alternative ways. For example, it can be made so that the contact surface of the elements 22 and 23 is placed exactly on the level of the support element surface, which in the drawing is illustrated by a dotted line 26. On both sides of the support element 25, there are made grooves seen in the illustration.

Another alternative is to make a groove in the element 23 according to the method described in connection with figure 1a and to manufacture the support element 25 and the signal cable 20 separately with respect to the sectional plane, starting from the sectional plane illustrated by the dotted line 27. The support element 25 and the signal cable 20 are in later manufacturing steps attached, as a uniform structure, on the bottom of the groove made in the element 23. The ground cable 21 is made either in the way described in connection with figure 1a, or it may be silk-screened in a groove of a suitable size provided in the element 22, if the contact surface of the elements 22 and 23 is the plane illustrated by the dotted line 26. When the elements 22, 23 and the support element 25 are connected, the ground cable 21 is

placed in the cable cavity in parallel with the signal cable 20. From the drawing it is seen that the electromagnetic field emitted from the signal cable 20 towards the ground cable 21, said field being illustrated by the power lines 24, clearly makes a shorter passage in the dielectric material, in the support element 25, than it has to make in the case of figure 1b, inside the element 13 made of a dielectric material. The major part of the transmission cable losses are composed exactly of the losses made in the dielectric material layer. As a consequence, the inverted microstrip cable according to the invention has a smaller attenuation per unit of length than the inverted microstrip cable according to the prior art. However, the impedance level of the transmission cable according to the invention can be adjusted to the desired magnitude, because the impedance of the transmission cable is affected by adjusting the outer dimensions of the support element 25 made of some dielectric material.

In the embodiment illustrated in figure 3, the signal cable 30 of an inverted microstrip cable is attached to a support element 35, which is narrowed in a triangular fashion towards the bottom of the transmission cable cavity. The cable structure according to the drawing is composed of at least two separate elements 32 and 33. The contact surface of the elements, which in the drawing is illustrated by the dotted line 36, is chosen to be the best possible with respect to the manufacturing of the structure. The contact surface 36 of the elements 32 and 33 can be, as is illustrated, the plane 30 of the signal cable attached to the support element 35, but it can also be some other plane. The support element 35 can be produced in connection with the production of the element 33, but it can also be produced separately, in which case its contact surface with the element 33 can be a plane which in the drawing is illustrated by the dotted line 37. Part of the electromagnetic field, illustrated by the power lines 34, emitted from the signal cable 30 towards the ground cable 31, proceeds for a short length inside the support element 35. The part of the electromagnetic field that is left inside the support element is smaller than the part left in the bottom substrate in the prior art arrangement illustrated in figure 1b. In the illustrated preferred embodiment, the attenuation per unit of length is thus lower than the attenuation of an inverted microstrip cable according to the prior art.

In the embodiment illustrated in figure 4, the signal cable 40 of an inverted microstrip cable is attached to a support element 45 that is wider towards the bottom of the groove made in the element 43. The illustrated structure is composed of at least two separate elements 42 and 43. The elements are treated so that inside

them, there is created a cable cavity according to the illustration. The contact surface of the elements 42 and 43, illustrated by the dotted line 46, is chosen to be the best possible with respect to the manufacturing of the product. The contact surface of the elements 42 and 43 can be, as is illustrated, a plane of the signal cable 40 attached to the support element 45, but it may also be another plane that is advantageous for the manufacturing process. In this embodiment, part of the electromagnetic field, illustrated by the power lines 44, emitted from the signal cable 40 towards the ground cable 41, proceeds through the support element 45. However, the part that passes through the support element is remarkably smaller than in the case of the prior art inverted microstrip cable illustrated in figure 1b. Thus the attenuation per unit of length also in this embodiment is lower than in a prior art inverted microstrip cable.

In the embodiment illustrated in figure 5, the signal cable 50 of an inverted microstrip cable is attached to a support element 55 having the shape of a T-beam. The walls encasing the transmission cable are composed of at least two elements 52 and 53, and the sectional plane perpendicular to the patterns of said elements, said sectional plane being illustrated by the dotted line 56, is chosen so that the number of work steps in the manufacturing process is minimised. The support element 55 can be manufactured in several alternative ways. One alternative is to produce the support element 55 and the signal cable 50 separately, starting from the plane at the base of the T-beam, which plane is illustrated by the dotted line 57. The support element 55 and the signal cable 50 are connected, as a uniform structure, to the element 52. The ground cable 51 can be produced for instance in the way illustrated in connection with figure 1b. When the elements 52, 53 and 55 are connected together, the ground cable 51 is located in the cable cavity on the opposite side of the signal cable 50. In figure 5 it is seen that the electromagnetic field emitted from the signal cable 50 towards the ground cable 51, which field in the drawing is illustrated by the power lines 54, passes only a short way in the dielectric material, in the support element 55. As a consequence, the inverted microstrip cable according to the drawing has an extremely low attenuation per length unit, in comparison with the attenuation of a prior art inverted microstrip cable.

In the embodiment illustrated in figure 6, the transmission cable structure is composed of at least two elements 62 and 63. The contact surface of the elements 62 and 63, illustrated by the dotted line 66, is chosen to be the best possible with respect to the manufacturing of the product. It may be located at the illustrated

point, in which case it is level with the surface of the support element 65, which in the drawing is illustrated by the dotted line 66. In this embodiment, the shape of the support element is inwardly curved. The support element 65 constitutes part of the element 63. Also in this embodiment only a small part of the electric field emitted from the signal cable 60, which in figure 6 is illustrated by the power lines 64, proceeds in the dielectric material of the support element. Likewise, also in this embodiment the attenuation of an inverted microstrip cable according to the invention is low in comparison with a corresponding prior art transmission cable.

In the embodiments described above, the inverted microstrip cable according to the invention is placed in a cable cavity made of dielectric material layers. The number of the layers constituting the cable cavity wall may vary according to the employed technique and to an optimal number of working steps. The wall strength of the created cable cavity is assumed to be so good in all directions, that the other ground potential levels possibly located in the surroundings are placed far enough in order to prevent the shape of the electromagnetic field of the transmission cable from being disturbed thereby.

The invention is not restricted to the described embodiments only. For example, the structure of the walls forming the cable cavity can be divided into various levels by innumerable different ways. The employed manufacturing technique determines which method of dividing the wall parts to be created is optimal with respect to expenses and output. Likewise, the shape of the support element according to the invention can deviate from the preferred embodiments illustrated above. Also the manufacturing method of the employed signal and ground cables may be other than the suggested silk screen method. Other known cable structures, for example coplanar cable, can also be employed as the cable used in the structure. The inventive idea can be applied in various different ways within the scope of the patent claims.

Claims

1. A transmission cable constructed by multilayer technique, located in a cavity comprising a first surface and a second surface essentially parallel with the first surface, said transmission cable consisting of a signal cable (20, 30, 40, 50, 60), which is essentially parallel to the first cavity surface, and of a ground cable (21, 31, 41, 51, 61), which is placed on said second surface, essentially in parallel with the signal cable, **characterised** in that said cable also comprises a support element (25, 35, 45, 55, 65) which has a surface that is essentially parallel with said first and second surfaces and is located between said first and second surfaces, so that the signal cable is realised by means of an electroconductive material layer formed on the surface of the support element.

2. A transmission cable according to claim 1, **characterised** in that said support element (25, 35, 45) is rectangular in shape.

3. A transmission cable according to claim 1, **characterised** in that the support element is a square (25).

4. A transmission cable according to claim 1, **characterised** in that shape of the support element is a T-beam (55).

5. A transmission cable according to claim 1, **characterised** in that the shape of the support element is a surface (65) formed by two curved surfaces.

6. A transmission cable according to claim 1, **characterised** in that the signal cable is an inverted microstrip cable.

7. A transmission cable according to claim 1, **characterised** in that the signal cable is a coplanar cable.

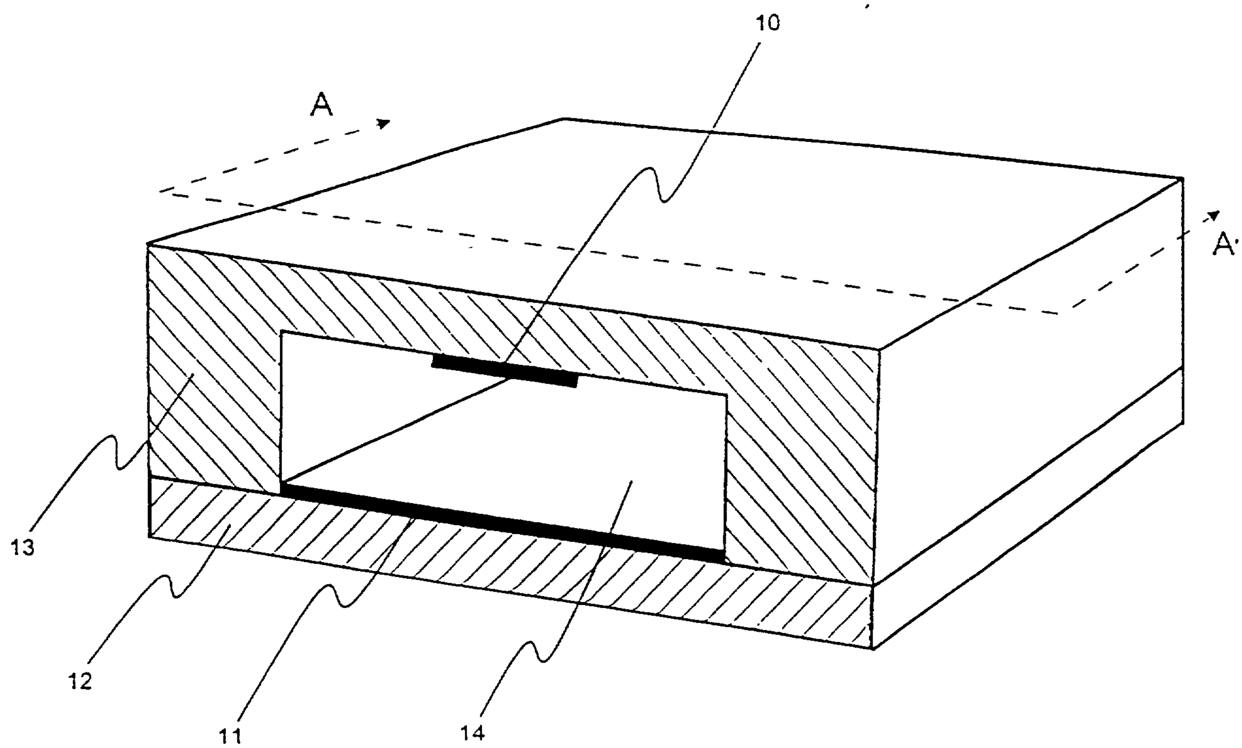


Fig. 1a

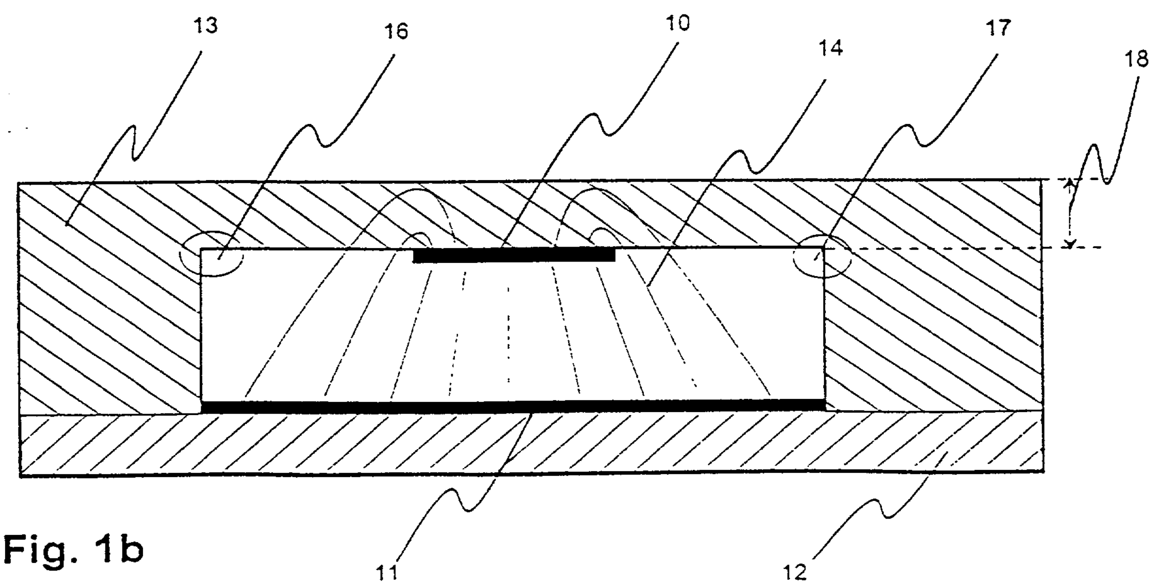


Fig. 1b

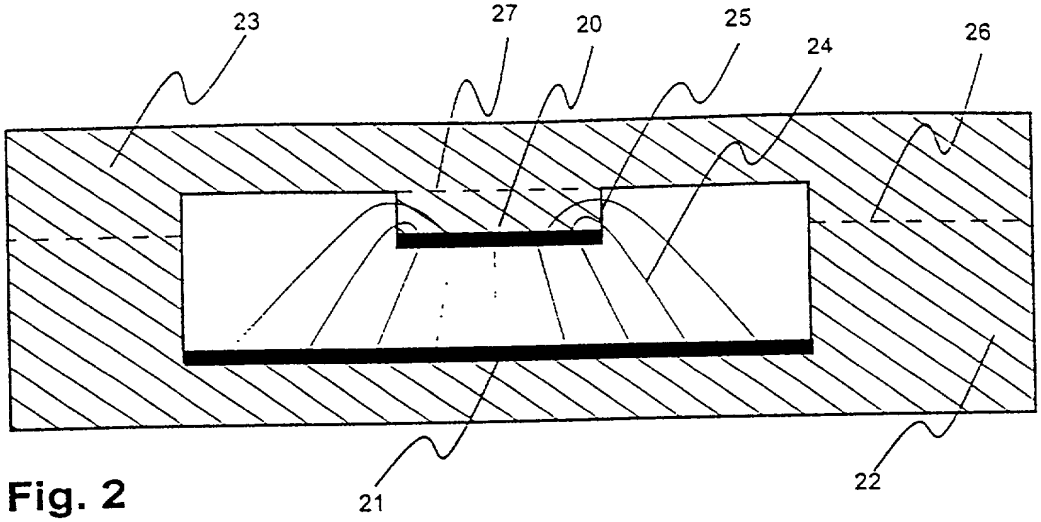


Fig. 2

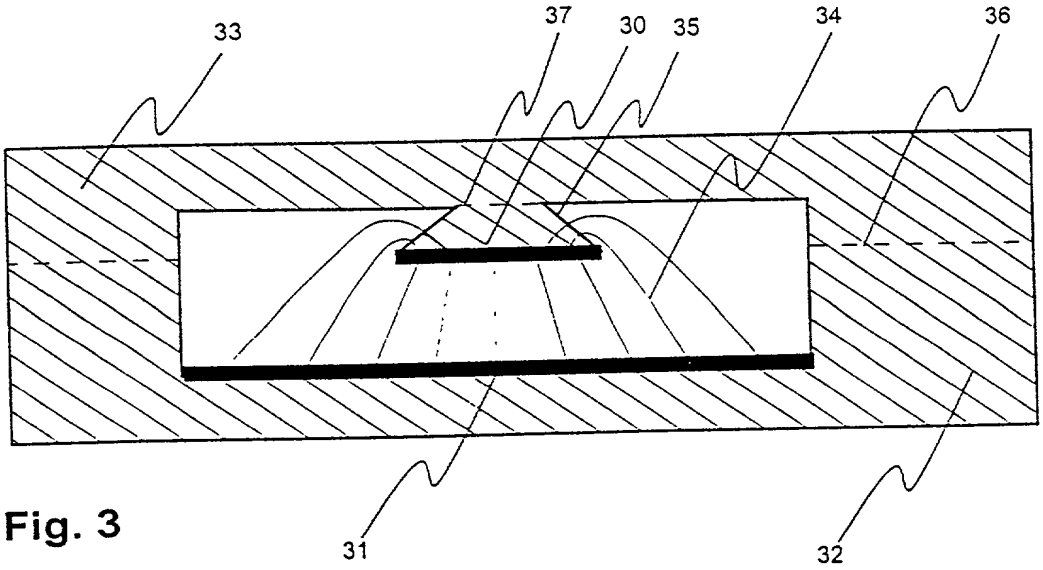


Fig. 3

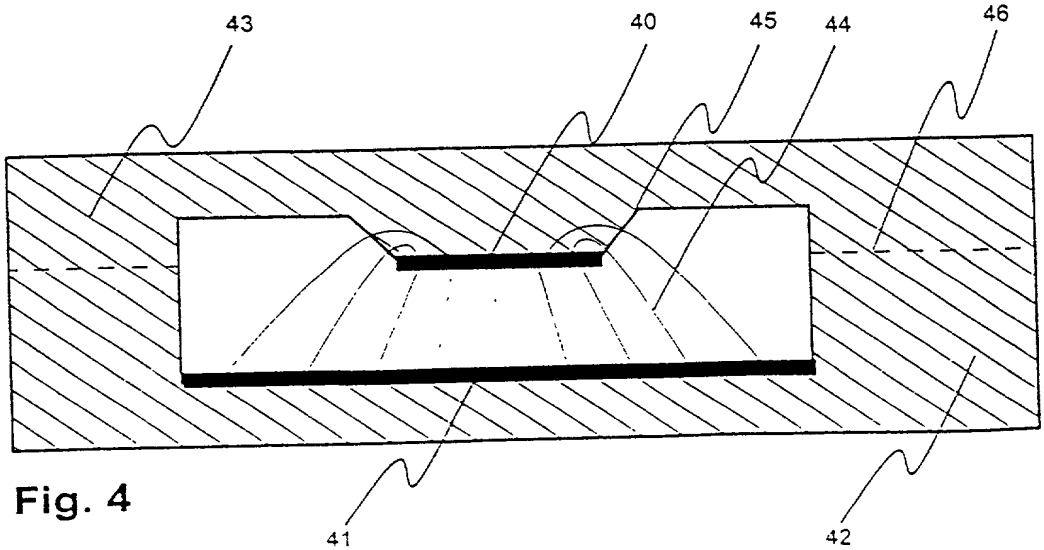


Fig. 4

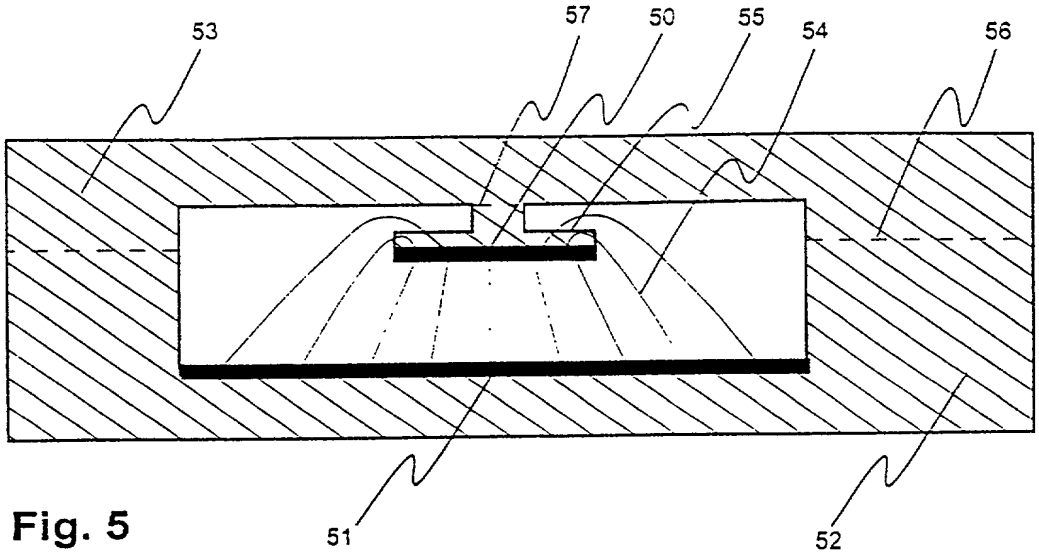


Fig. 5

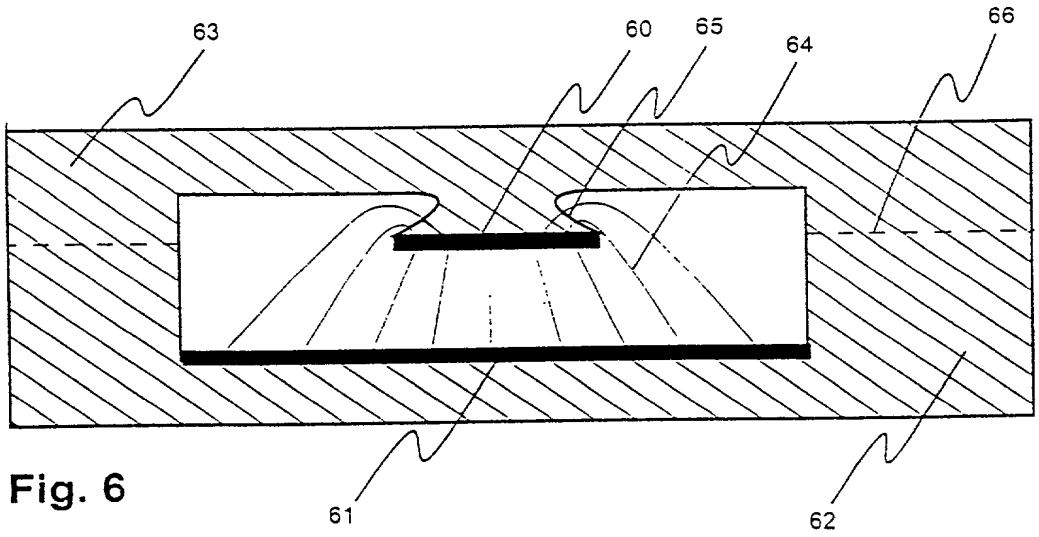
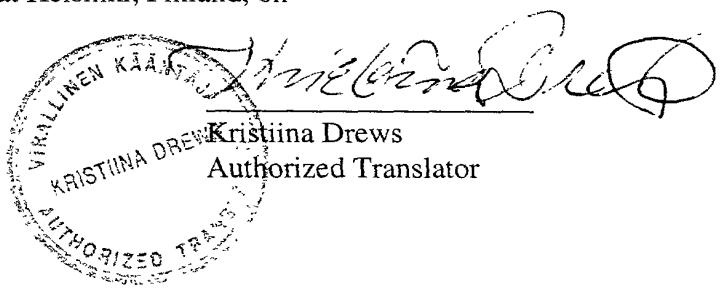


Fig. 6

DECLARATION

I hereby declare that to the best of my knowledge and belief the following is a true translation of a certified copy of the Finnish Patent Application No. 990717 filed on 31 March 1999.

Declared at Helsinki, Finland, on



Kristiina Drews
Authorized Translator

Docket No.: _____

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: **Inverted microstrip transmission line integrated in a multilayer structure**

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on as United States Application No. or PCT International Application Number _____

and was amended on (if applicable) _____

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International Application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Not Claimed
990717	Finland	31 March 1999	☐
PCT/FI00/00274	PCT	30 March 2000	☐
			☐
			☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

_____ _____
(Application Serial No.) (Filing Date)

_____ _____
(Application Serial No.) (Filing Date)

_____ _____
(Application Serial No.: (Filing Date)

I hereby claim the benefit under 35 U.S.C. Section 120 of any United States application(s), or Section 365(c) of any PCT International Application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International Application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C.F.R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

_____ _____ _____
(Application Serial No.) (Filing Date) (Status)
(patented, pending, abandoned)

_____ _____
(Application Serial No.) (Filing Date) (Status)
(patented, pending, abandoned)

_____ _____ _____
(Application Serial No.) (Filing Date) (Status)
(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

All attorneys listed under Customer No.: 2512

Send Correspondence to:

Customer No.: 2512

Direct Telephone Calls to: (name and telephone number)
Clarence A. Green, Reg. No.: 24,622 (203) 259-1800

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Second inventor's signature: DATE
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Post Office Address:

Full name of third inventor.

Third Inventor's signature: DATE

Residence address:

Citizenship

Post Office Address:

Full name of fourth inventor

Fourth inventor's signature: DATE

Residence address:

Citizenship

Post Office Address

Full name of fifth inventor

Fifth inventor's signature: DATE

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